Review article

# Sign machines in the framework of *Semiotics Unbounded**

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## 1. *Semiotics Unbounded*

In contrast to semioticians who postulate thresholds or boundaries between their semiotic field and the nonsemiotic domains of study in a dualistic universe in which signs are opposed to objects without semiotic relevance (cf. Nöth 2000), Susan Petrilli and Augusto Ponzio (2005) have outlined an *unbounded* semiotic universe with an 'open network of signs,' a semiotics of universal applicability and global responsibility.

According to the Bari semioticians, the field of semiotic studies has expanded in the course of the twentieth century to the degree that semiotics liberated itself from its structuralist heritage. The gallery of the founding fathers and mothers of semiotic studies presented in *Semiotics Unbounded* (pp. 33–340) begins in the prestructuralist nineteenth century with Charles Sanders Peirce (1839–1914) and his English contemporary Victoria Lady Welby (1837–1912); its twentieth century protagonists are Mikhail M. Bakhtin (1895–1975), Charles Morris (1901–1979), Thomas A. Sebeok (1920–2001), and Ferruccio Rossi-Landi (1921–1985). Umberto Eco's contributions to semiotics are not ignored (pp. 298–340), but in Bari, the structuralist heritage of Eco's semiotic theory is seen from a critical distance. Other semioticians of the structuralist line of descent have no place in Petrilli's and Ponzio's otherwise unbounded Valhalla of famous semioticians.

Twentieth century semiotics, according to Petrilli and Ponzio, has offered new perspectives on such diverse domains of research as linguistics, literary criticism, cultural anthropology, psychology, philosophy, biology, and mathematical topology (p. 4). By their account of the expansion of the semiotic field during the last decades, which their blurb to *Semiotics Unbounded* calls an 'explosion of the sign network in the era of global

* Susan Petrilli and Augusto Ponzio, *Semiotics Unbounded: Interpretive Routes Through the Open Network of Signs*, Toronto: University of Toronto Press, 2005.

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communication,' the authors are especially indebted to Sebeok's 'global semiotics' with its great strides towards extending the narrow scope of the glotto- and anthropocentric tradition to the new horizons of signs in a broader biological realm (pp. 5–6).

Although *Semiotics Unbounded* is itself mainly concerned with topics of culture and *human* communication such as otherness, dialogue, writing and literature (pp. 341–428), understanding, misunderstanding, argumentation, semioethics, or global communication (pp. 429–558), *biosemiotic aspects* are always taken into consideration. Not only do those 'masters of semiotics' gain special attention who have explicitly dealt with signs in non- or subhuman domains (Peirce, Morris, Sebeok, Thure and Jakob von Uexküll) but Petrilli and Ponzio also present new biosemiotic aspects in the writings of those masters of semiotics who have hitherto mostly been seen in an anthroposemiotic perspective: Lady Welby's significs, for example, is reinterpreted from a biosemiotic viewpoint as a 'biosensifics' (pp. 102–134); the reader learns that Bakhtin's dialogism has a biosemiotic foundation (pp. 144–151, 352–356), and even biosemiotic aspects of Rossi-Landi's Marxist semiotic theory of the homologies between human semiosis, work, and trade, are revealed (p. 261, 269–271).

If then, according to this perspective of global semiotics, 'sign processes coincide with life' (p. xvii), it may come as a surprise that Petrilli's and Ponzio's outline of the field of semiotic studies includes a domain which does not coincide with life at all, namely intelligent machines. The topic is dealt with in chapter 11.3 under the heading 'The sign machine: Linguistic work and global communication'; the following paragraphs are restricted to this topic.

## 2. Semiotic features of Petrilli's and Ponzio's sign machine in a synechistic perspective

According to the preface to *Semiotics Unbounded* (p. xxv), the chapter on the sign machine was written by Susan Petrilli, but Augusto Ponzio, too, has written on machines in the context of human communication. There is even some overlap between Petrilli's and Ponzio's writings in passages in which both authors back up their theses on the role of automation in relation to labor with a chapter on the cultural history of machines from Karl Marx's writings (p. 506, and Ponzio 1999: 84). It should therefore not be against the collaborative spirit of the authors to refer to the topic of the present paper as Petrilli's and Ponzio's sign machine.

The major characteristics of sign machines according to *Semiotics Unbounded* can be summarized in a list of ten statements, some of which make rather strong claims to the semiotic nature of these machines, whereas others involve weaker claims. The order of the statements in the following list of ten is according to the strength of their claims, from the weakest to the strongest. The stronger a claim concerning the semiotic nature of an intelligent machine the more likely it is to face counterarguments.

1. A sign machine is an 'extension of human beings' (p. 502) and an 'instrument of human labor' (p. 506).
2. Insofar as a machine is automatic, it has become 'autonomous,' but whereas automatic machines of the assembly line generation subjugate their laborers and make them their instruments, human beings interacting with intelligent machines 'become active subjects once again' since these machines, instead of requiring repetitive manual work, ask for intelligent human collaboration (pp. 506–508).
3. A sign machine is 'in a position to replace intellectual work' (p. 503).
4. It is 'intelligent' (p. 502).
5. It is 'endowed with language understood as a modeling capacity' (p. 502).
6. It 'extends semiosis to the inorganic' (p. 505).
7. It is endowed with 'semiotics understood as *metasemiosis*, . . . the capacity for interpreting other semiosical processes and therefore for *metacommunication*' (pp. 502, 505).
8. It is endowed with the capacity for innovation and creativity (p. 502).
9. It participates in 'the alterity of the other,' in a materiality of the highest degree, 'where alterity is encounter with others' (pp. 516–517), and for this reason:
10. It elicits 'responsibility for others, ethical responsibility, awareness not only of the cognitive order but also of the ethical order' (pp. 516–517).

Several of the arguments in this list have been hotly debated by philosophers of mind who have either maintained or rejected the claim that machines can think or might once be able to do so (see, e.g., Berkeley 1949; Graubard 1988). However, the purpose of the following discussion is neither to defend Petrilli's and Ponzio's weaker claims nor to refute their stronger ones against the background of this debate. What is rejected, though, as a false Cartesian premise, is the strict dualism between mind and matter, intelligent thought and mechanical processes, which can be found in the Artificial Intelligence (AI) debate and which has been the source of the dispute between those who believe that machines can think and those who reject the idea of a 'ghost in the machine' as a science fiction argument. The alternative premise on which the present paper is based is Peirce's synechism, a topic also introduced by the authors of *Semiotics Unbounded* (pp. 50–52). It is the doctrine which rejects dualisms such as the one between mind and matter as the products of a 'philosophy which performs its analyses with an axe' (*CP* 7.570, ca. 1892) and which postulates instead continuity between categories such as mind versus matter, human semiosis versus the world of physical objects (see also Nöth 2002). The consequence of this premise for the study of Ponzio's and Petrilli's ten claims is that they must not be examined in terms of approval or rejection. Instead, the question to be resolved is *to which degree* these claims concerning the semiotic nature of machines are valid and to which degree they are not.

## 3. Sign machines between mind and matter

Before discussing the authors' less controversial semiotic characterizations of sign machines, we will consider the place of such machines in the continuum between mind and matter from the perspective of the tenth claim, which can best demonstrate Petrilli's and Ponzio's position in the dispute between the dualists.

### 3.1. *Efficient causality in the semioethics of intelligent machines*

Claim 10 is evidently the strongest of all, most likely to be challenged by the dualists. Can a computer be held ethically responsible for any information it might provide? Can a robot be held responsible for a mechanical 'command' by which it 'controls' some automatic mechanical process?

Like any other medium whose message can be moral or immoral, the information provided by means of a computer may be morally reprehensible. Child pornography made accessible via the World Wide Web is a much debated example of Internet criminality, but are not pornographic sites of their producers' responsibility? Full ethical responsibility presupposes the freedom to decide between the morally good and the bad; there must be purposes and consequences which can be evaluated in terms of merit, guilt, or innocence. Computers are neither responsible nor guilty of the information they provide. The World Wide Web providing child pornography does not have the intention of doing so and hence cannot be found guilty for the material it provides. On the other hand, it is true that without the Internet access and Internet service providers, child pornography could not install itself in a World Wide Web so that some involvement of the medium cannot be denied in the immoral processes of semiosis in question.

There are hence two semiotic causes involved in this semioethical scenario, a principal cause, the immoral purpose and interest of a criminal who produces and offers child pornography and another cause which is the medium of the Internet; the latter is insofar causally involved as no viewer could download or see child pornography, and no criminal could be motivated to produce and distribute it if there were no Internet. The difference between these two causes is one which Peirce, in his semiotic theory of causality, describes as the difference between final and efficient causes (cf. Santaella 1999). Final causality is the long term causality of purposes, intentions, ideas, signs, and general laws, all of which belong to the Peircean category of thirdness. Efficient causality, by contrast, is the one of immediate causes, which belong to the category of secondness. It is the causality due to the event immediately preceding the effect, triggering it mechanically of by some other force without being its principal cause (*CP* 6.600, 1893). Peirce calls efficient causality also 'a compulsion determined by the particular condition of things ... acting to make that situation begin to change in a perfectly determinate way' (*CP* 1.212, 1903). Mechanical causality (Short 2007: 136) is a form of this causality, but there are other forms of efficient causality.

The purpose of the criminal is hence the final cause of our semioethical pornographic scenario. The medium of the Internet is one of its efficient causes. Every final cause needs an efficient cause to reach its effect, but one and the same final cause may reach its goal by different efficient causes, since 'final causation does not determine in what particular way it is to be brought about, but only that the result shall have a certain general character' (*CP* 1.211, 1902). The criminal purpose of producing and distributing child pornography, for example, may be reached by mail, video, or Internet. Peirce describes this role of the medium as an efficient cause in semiosis as follows:

> Did it ever occur to you, my reader, that an idea without efficiency is something ... absurd and unthinkable? Imagine such an idea if you can! Have you done so? Well, where did you get this idea? If it was communicated to you viva voce from another person, it must have had efficiency enough to get the particles of air vibrating. If you read it in a newspaper, it had set a monstrous printing press in motion ... Final causality cannot be imagined without efficient causality. (*CP* 1.213, 1902)

The idea and the result of its interpretation, the interpretant of the sign, is hence the final cause of semiosis, whereas the message and the medium that convey the idea vocally in verbal communication or in print in the newspaper are its efficient cause. Not only the medium but even the material tools of writing such as the inkstand used to write down an author's idea are efficient causes of an author's ideas. Peirce even goes further. Rejecting the physiological theory of the localizability of ideas in the human brain, currently still held by the advocates of the causal theory of the human mind, he argues that not even the cerebral neurons excited while thinking about a given idea are final causes of this idea but only their efficient causes. The much quoted passage in which Peirce draws this daring parallelism between the inkstand and the human brain is the following:

> A psychologist cuts out a lobe of my brain ... and then, when I find I cannot express myself, he says, 'You see your faculty of language was localized in that lobe.' No doubt it was; and so, if he had filched my inkstand, I should not have been able to continue my discussion until I had got another. Yea, the very thoughts would not come to me. So my faculty of discussion is equally localized in my inkstand. It is localization in a sense in which a thing may be in two places at once. (*CP* 7.366, 1902)

Whereas (in accordance with the principle that thirdness involves by necessity secondness) every final cause needs an efficient cause to reach or to realize its effect, efficient causes may exist without final causes (in accordance with the principle that secondness does not presuppose thirdness). Examples of efficient causes without final causes are the causes involved in accidents.

An intelligent machine, a computer, designed to control a guided missile gets out of control because of a technical defect and becomes the cause of the death of innocent victims. Is the scenario semioethically relevant? In contrast to the previous examples, neither efficient nor final human causality is involved in this event. The signal out of control giving the 'command' to launch the missile is a merely mechanically efficient cause of the death of innocent people, but nevertheless, the machine is not called 'guilty'; it lacks any final causality and has no purpose of killing those people nor was it designed to do so. Intelligent machines do not 'control' technical processes in the same way human controllers do since they lack intentionality; only the purposes of a human controller exhibit final causality; the machine operates by efficient causality only. Nevertheless, without the technical defect in the machine as the efficient cause of the ensuing disaster, the accident would not have happened, so that in extension of Peirce's argument, we can say that the semioethical cause is 'also localized' in the machine.

In sum, the semioethics of intelligent machines is one of efficient causality as long as computers are without intentions. In principle, not only the computer, but all media evince this kind of efficient causality in sign processes, from the medium of the letter in a blackmail attempt to the medium of the radio in the propagation of Hitler's fascist ideology so pertinently characterized by Marshall McLuhan (1964).

### 3.2. *Human extensions, signs, and instruments of human beings*

Let us now turn to the less controversial claims concerning the involvement of machines in semiosis. Claim 1, of the sign machine as an extension and instrument of the human being, is certainly the weakest of all, and it is therefore widely accepted. However, if we follow Marshall McLuhan's (1964) thesis that the media in general are 'extensions of man,' not only sign machines, which are media, but all other media are extensions of humans. Hence, claim 1 cannot sustain alone the argument for the semiotic nature of intelligent machines nor can the claim that sign machines are instruments of their users do so. Furthermore, not only sign machines but all machines are 'extensions' of human beings, and in addition also their cultural precursors, human tools, are extensions of this kind. Flusser (1997 [1983]: 22), for example, describes the most primitive human tools as cultural extensions of the human body, the hammer as an extension of the human fist, the arrow as an extension of human fingers, or the axe as a cultural extension of human teeth.

As uncontroversial as it sounds, the thesis of the instrumentality of the media has its opponents. With his famous tenet that the 'medium is the message,' Marshall McLuhan, for example, defended the argument that signs in the media are not only instruments for conveying messages about their referents but also convey meanings inherent in their own mediality. In addition to the fact, event, opinion, or story about which it may inform or entertain, a message in the media is always also a message about the media, and the media, for their part, are signs, too, since the 'content' of a medium, according to McLuhan (1964: 8), 'is always another medium' (cf. Nöth 2007).

Charles S. Peirce, to whom 'medium' and 'sign' were synonyms, had other objections against the theory of the instrumentality of signs and the media. Although, in a way, it is true that human sign users create the signs and use them as their extensions, it is also true that humans are themselves signs (cf. Ponzio 1990). Now, if humans are signs, and signs are instruments, which instrumental purpose do we humans serve? The idea that sign users, like messengers, are instruments serving to convey somebody else's message is against the basic assumption of the autonomy of human beings.

Nevertheless, in the processes of semiosis, sign users are not fully autonomous semiotic beings. The signs they use in order to communicate their ideas are by no means mere creations of autonomous sign creators since each sign is for its part determined by its object. In the endless chain of semiosis, the object of the sign determines the sign to create an interpretant. It is not the sender of a message that determines the receiver's mind but the sign, which, in the case of a verbal message, is the word. This is why 'words only stand for the objects they do, and signify the qualities they do, because they will determine, in the mind of the auditor, corresponding signs' (*CP* 2.92, 1902). In human cognition and communication, the sign does not only represent its object to the mind of an interpreter; the object represented by the sign is also 'in a sense the cause, or determinant, of the sign even if the sign represents its object falsely' (*CP* 6.347, 1909; cf. Parmentier 1985). To the degree that it is determined by its object, the sign is itself 'used' by the object for the purpose of representation. Thus, it cannot only be an autonomous sign user who represents the object *by means of* a sign. To the degree that their signs are determined by their objects, the so-called sign users cannot be the masters of their signs.

Among the most characteristic objects by which sign machines are determined is the digital logic of their programs which decides what the machine can or cannot do and the world-wide net of selective information which determines what the users can or cannot access and interpret. To the degree to which intelligent machines are determined by their objects, their users cannot claim that they use them as their instruments; instead, they are themselves being used by their machine as the mediators of its signs. The semiotic circularity involved in this process is not unique and restricted to the interaction of humans with machines, though. It is a general characteristic of human semiosis which begins with the use of any verbal symbols. According to Peirce:

> Man makes the word, and the word means nothing which the man has not made it mean, and that only to some man. But since man can think only by means of words or other external symbols, these might turn round and say: 'You mean nothing which we have not taught you, and then only so far as you address some word as the interpretant of your thought.' In fact, therefore, men and words reciprocally educate each other. (*CP* 5.313, 1868)

From these premises, Petrilli's and Ponzio's claim 2 concerning the paradigm shift from autonomous automatic machines of the assembly line generation which used to transform their supervisors 'into instruments subaltern to the machine and its functioning,' obliging them to merely 'intervene, supplement, and complete operations' otherwise carried out automatically (p. 506) to intelligent machines interacting with their users in active mutual collaboration should be revised in a synechistic vein. Apart from the fact that the manual maintenance of any automatic machine requires collaborative intelligent work, too (see 3.3), Peirce's synechistic doctrine of the interdependencies between humans, their instruments, and their signs teaches that *all* extensions of humans, from the early primitive tools of *homo habilis* to the automatic machines of the age of industrialization and to the intelligent machines of the age of the World Wide Web evince a bidirectional causality according to which the extensions of humans determine the thus extended humans and vice versa. It is only a matter of degree whether the laborers in the service of a semi-automatic machine or the users of intelligent machines updating their programs, protecting them against viruses, or doing maintenance work are more the instrument of the machine than the machine is their instrument.

## 3.3. *Replacement of intellectual work and semiosis in the Chinese Room*

Claim 3 that sign machines replace intellectual, not only physical, work, as earlier machines did, will equally find wide consensus. Nevertheless, the degree of this consensus depends on the definition of 'intellectual work.' If copying or rewriting a text, error correction, translating words and unambiguous sentences, or data mining, the retrieval of information from huge databases, is intellectual work, nobody will be able to doubt that computers carry out intellectual work. If, however, intellectual work is a synonym of work which requires 'thinking,' all those philosophers of mind who claim that computers cannot think will object.

Ponzio (1999: 83) describes the ability of performing intellectual work as a revolutionary novelty in the history of machines, the origin of a second industrial revolution. His argument is: 'The *second industrial revolution* consists in the *substitution* of intellectual force by means of automatic machines, whereas the first industrial revolution made the *substitution of physical force* possible.' The authors of *Semiotics Unbounded* are right in concluding that, in the era of intelligent machines, the old distinction between manual and intellectual work is no longer tenable when they state:

> The intelligent machine activates linguistic work, and human beings participate in the process in their wholeness, at both the mental and the physical level. Think of the trivial 'labor' of key stroking and of the competencies it requires in terms of manual work — competencies that cannot be separated from the mental

work that is simultaneously involved whenever someone operates a computer. (p. 515)

The argument can be extended and held up to Searle (1980), who develops the following thought experiment: a man who knows only English is locked up in a room with an input slot through which he receives questions written in Chinese. His task is to deliver a written answer in Chinese through an output slot of his room. The means by which he succeeds in this task are a set of cards for identifying the input characters by comparison and a code book written in English with instructions for substituting these characters for other characters and rearranging them in a new order. Although he succeeds, and the Chinese readers of his output message believe that he knows Chinese, Searle concludes, that the man in the Chinese Room only *simulates* a command of the language unknown to him and that, like a parrot that does not understand its own words, he is without the intelligence required to understand and produce meaning in a foreign language.

The code book and its manipulation in the Chinese Room is, of course, a metaphor of the computer program at work in the interface of humans with intelligent machines. The man in the Chinese Room is the Homunculus at work in the processing of language in a computer of the Artificial Intelligence generation. Searle created this parable as an argument against the Artificial Intelligence project and its strong claims concerning the intelligence of computers and their ability to think. Underlying Searle's argument is a rationalist disrespect for manual work that can be delegated to a machine. The implication of the parable is that intelligence is not necessary to carry out the work of the Homunculus in the Chinese Room even though the result of his work may be the same as the one of the work of an intelligent Chinese reading and answering the same questions under the same circumstances.

The argument underlying Searle's parable is evidently that intelligence is only associated with thinking and speaking, whereas manual work requires no intelligence. Only this interpretation makes the parable a useful argument against the AI claim for the intelligence of intelligent machines, but Searle's rationalism ignores that not only verbal communication but also planning and executing manual work undoubtedly require thinking. Although thought is possible without manual manipulations, manual activities are not possible without thought. It is no coincidence that the areas of the human brain which coordinate the facial expressions, movements of the tongue, lips, and the jaw during speech articulation are of equal size as the ones which coordinate the movements of the hands and arms (Geschwind 1982: 112). The great cerebral prominence of the hand is not really surprising considering the evolutionary parallels between hand and speech (Leroi-Gourhan 1988 [1964–1965]: 188–189). Although often neglected by the rationalists, the interdependencies between human hands and intelligence have been recognized as early as in Greek antiquity. Plato, for example, reports that 'Anaxagoras says that man is the most intelligent of animals because he has hands' (*De part. anim.* iv. 10; 687a 7).

In this context, the validity of Petrilli's and Ponzio's premise concerning the inseparability of mental and physical work finds full support, but their conclusion that the advent of machines with the capacity for intellectual work 'involves a leap of a qualitative order' (p. 515) merits a revision and extension. The evolutionary leap that introduced the second industrial revolution was not a qualitative one since manual work has always required thinking and has hence always involved intellectual work. Instead, the leap has been a quantitative one. To the degree that they are capable of substituting human intellectual work, intelligent machines surpass the human capacity of work in quantity and, above all, in speed.

Searle, by contrast, neglects the principle of the inseparability of manual from intellectual work in his interpretation of our Homunculus's selecting and reordering Chinese characters by means of instructions from a code book. He ignores that, although the man in the Chinese Room neither understands what his input symbols mean nor what they refer to, he must nevertheless be able to think while solving the quite difficult task of identifying the symbol tokens as belonging to a type among a set of thousands of cards. Furthermore, he also has to think while carrying out the most difficult task of following the code book instructions, which must be of an extreme complexity, and finally, he has to evince the capacity of thinking while assembling them into a new syntax.

It is true, though, that Searle's Homunculus, like any a machine that manipulates verbal signs merely by syntactic recognition and recombination, cannot be said to understand its meaning (see 3.5). The signs of the input message are verbal symbols, and a man locked up in a room without windows to the world to see or to have seen the objects of these symbols cannot create their interpretants. What is missing to open such a window is the previously lived experience associated with the symbols, which Peirce calls 'collateral observation':

> The Sign creates something in the Mind of the Interpreter ... called the Interpretant ... All that part of the understanding of the Sign which the Interpreting Mind has needed collateral observation for is outside the Interpretant. I do not mean by 'collateral observation' acquaintance with the system of signs. What is so gathered is not COLLATERAL. It is on the contrary the prerequisite for getting any idea signified by the sign. But by collateral observation, I mean previous acquaintance with what the sign denotes. (*CP* 8.179, 1903)

As long as the collateral experience of the objects of the input symbols is missing, the Chinese characters remain undeciphered, and they are mere signals which do not become signs.

However, despite his inability of accessing the interpretants of his messages, the man in the Chinese Room is nevertheless able to create pertinent interpretants in the minds of his Chinese readers at the output slot of his room. It is true that his involvement in the process of creating interpretants in his readers' minds is reduced to one of efficient causality since the man serves as a deterministic medium in the dialogue between those who ask questions and those who receive the answers as long as he can only follow blindly the instructions given to him. However, our mediator of symbols which he cannot interpret is nevertheless involved in modes of semiosis of a different kind. Whenever he compares one of his input characters with the cards from his file of all possible Chinese characters in order to select the right card, our mediator or machine Homunculus is manipulating iconic signs, since recognizing by similarity or sameness is to recognize an iconic sign. Whenever he proceeds to rearrange these characters in a new order according to instructions, he interprets indexical signs (cf. Nöth 1997). Since our Homunculus is but a metaphor of what is going on in an intelligent machine, we have to conclude that the intelligent machine is unable to interpret the symbols which it is processing, but that it evinces a superb capability of manipulating its input signs in iconic and indexical ways. It is important, though, to emphasize that the icons and the indices processed by the machine are exclusively internal icons and internal indices, signs whose objects are states of the machine or its input. The internal icons and indices processed by the computer do not refer to objects in the world without the intelligent machine.

### 3.4. *Intelligence*

Claim 4 that sign machines are intelligent is closely related to claim 3 that sign machines replace intellectual work. If 'intellectual' is taken in its sense of 'able to think intelligently,' 'intelligent work' and 'intellectual work' are synonymous expressions, and the difference between the claims 3 and 4 is reduced to the difference between the weaker claim that these machines merely replace intelligent work and the stronger claim that the machine *is* intelligent. With his parable of the Chinese Room, John Searle wanted to illustrate precisely the difference between these two claims. Searle would not object to the interpretation that the Homunculus in his Chinese Room is indeed replacing input by output signs, but he rejects the idea that such transformations might be considered as intelligent.

Nevertheless, and despite of Searle, the claim that computers are intelligent machines or even machines that can think has been widely held since Berkeley (1949) and Turing (1950) first suggested this possibility, although the claim, which constitutes the core of research in Artificial Intelligence (AI), is still not uncontroversial (cf. Graubard 1988). Once more, its tenability depends on the definition of intelligence. Basic mathematical operations such as addition, subtraction, multiplication, or division evidently require human intelligence. Peirce reminds us: 'Although not all reasoning is computing, it is certainly true that numerical computation is reasoning' (*CP* 2.56, 1902). Only machines, not animals (Sebeok and Rosenthal 1981) have been discovered that could replace humans even in simple mathematical tasks, and since computers are able to perform such operations and even surpass the human capacity of doing so in speed and precision, machines are often called intelligent. However, mechanical adding machines have been in use for centuries, and even machines able to solve logical problems have existed for more than a century (Peirce 1887). Hence, the intelligence required to perform these operations is in principle not specific to computers of the Artificial Intelligence generation. Since the invention of the first mechanical adding machine, intelligent machines have been at the service of humans.

It is true, though, that in current AI research, intelligence is usually not yet ascribed to machines processing numbers according to mathematical axioms. The classical manifesto of the AI paradigm, Allan Newell's paper on *physical symbol systems* (1980), describes the birth of intelligence in machines precisely as the point of transition from the calculating machine to machines capable of processing verbal symbols. Almost half a century ago, together with Simon, Newell affirmed claims of equal strength as those set up by Petrilli and Ponzio concerning the semiotic potential of intelligent machines, when Simon and Newell declared: 'There are now in the world machines that think, that learn and that create. Moreover, their ability to do these things is going to increase rapidly until — in a visible future — the range of problems they can handle will be coextensive with the range to which the human mind has been applied' (1958: 6).

Despite the consensus between AI scholars who unanimously agree that intelligent machines exist and are in use, a major objection against the claim for intelligence in computers cannot be ignored. It is the argument that the intelligence of humans is due to its cerebral capacity for parallel processing, which operates quite differently from the linear way digital computers operate. For this reason, scholars such as Reeke and Edelman (1988: 170) have asked for a revision of the traditional criteria of intelligence in order to take into consideration the 'relevant facts about biological systems that actually have intelligence' and to 'abandon the notion of intelligence as a purely abstract information-processing activity.'

### 3.5. *Language as a modeling capacity*

Claim 5 that intelligent machines are 'endowed with language understood as a modeling capacity' is in accordance with the claims held in the artificial intelligence paradigm, especially Newell's theory of the computer as a physical symbol system. Computers certainly process verbal symbols, but again, the question should not be whether they do or not, but to which degree they do.

Charles Morris, to whom Petrilli and Ponzio have dedicated an extensive chapter of *Semiotics Unbounded* (pp. 167–202), has taught that mastering a language (as well as any other sign system) means to master its three domains, syntax, semantics, and pragmatics. All criteria which Morris establishes for a sign system with a syntax are fulfilled by an intelligent machine: any computer with a language program to suggest or carry out corrections has a command of 'the formal relations of signs to one another' (Morris 1970 [1938]: 6); it has rules to decide 'the way in which signs of various classes are combined to form compound signs' (Morris 1971 [1946]: 367); and it produces 'sign combinations ... subject to syntactical rules' (Morris 1970 [1938]: 14). A computer of the Turing machine generation is certainly a syntactic machine (cf. 2.2)

A command of syntax is undoubtedly a semiotic capability of a machine working with symbols, rules and algorithms; but do intelligent machines also master semantics? It all depends on the definition of semantics. If semantics means lexical, sentence, and text semantics, the study of sense as lexical decomposition, operating with semantic primitives, and recomposing them to more complex semantic units, deriving meanings from schemata and scripts by inference, intra- or interlingual translation, then computers have semantic representations in their programs just as humans derive meanings from their mental models (cf. Johnson-Laird 1983).

However, if semantics presupposes collateral experience (cf. 3.3) of the objects of reference or is considered as referential semantics, as the early Morris defined it when he called semantics the study of 'the relation of signs to their designata,' to 'that which the sign refers to' (1970 [1938]: 21, 3), then computers do not master semantics. They cannot really interpret the symbols they process and also lack genuinely indexical signs to refer to objects in their *umwelt*, which they cannot see, feel, touch ('grasp'), smell, or otherwise experience independently of the lists of words which have been implanted in their programs (cf. Nöth 2001b).

If pragmatics is concerned with 'the relation of signs to their interpreters' or even 'the origin, the uses, and the effects of signs' (Morris 1970 [1938]: 30; 1971 [1946]: 365), what is true of the semantic interaction of intelligent machines with their *umwelt* must be even more true of their pragmatic interaction. After all, the interpreters are part of the *umwelt* to which intelligent machines have only an incomplete access so far. It is true that the interaction between humans and intelligent machines has become complex and highly diversified. Computer games testify to the degree to which intelligent machines can involve and fascinate their users in this interaction, but books can fascinate their readers, too, although nobody would say they communicate with their readers. As media, both books and computers capture their readers' imagination as efficient causes whose final causes are authors and creative designers even though the degree of the players' sensorial involvement in multimedia games is higher than the one of the readers reading a book.

A fully developed linguistic pragmatics requires far more complex capacities of verbal and nonverbal interaction than those which have been developed for computers so far, not only the consideration of referential visual and nonverbal data, but also the capacity to perform speech acts based on mere beliefs, assumptions, not only logical implications but mere pragmatic implicatures (Levinson 1989). Some of these capacities have already been developed to a certain degree, others not. Are computers polite, can they be impolite, or do they merely simulate politeness? To the degree that their language programs use polite words, they seem to be polite, but can a computer feel insulted by impolite user inputs? Can they make promises? Learning programs do when they announce rewards in response to correct answers, but they do not do so with the purpose of receiving the correct answers or even instructing their users to improve their knowledge. Can computers lie? They can certainly be programmed to make false statements, but they do not have the intention to deceive their users. Can computers express feelings? No, they can only simulate to do so because they have no feelings nor consciousness. Can computers joke? They can tell jokes fully programmed to be told, but since most jokes are based on ambiguities and metaphors and the capacities of computers to process ambiguities are still very limited, they are far from being able to produce new jokes.

In sum, if to dominate a language means to have a 'modeling capacity' and if modeling is 'the ability to construct a multiplicity of different possible worlds' (p. 561) then the consequence that intelligent machines are creators, not only of models of the world but also of a multiplicity of different possible worlds, is too strong. If, however, the capacity of modeling means only 'reproducing on the basis of a model or schema, be it ideal or real' (p. 18), then computers can certainly be said to master human language.

## 4. Semiosis in the inorganic?

Petrilli's and Ponzio's claim 6 states that intelligent machines are the only instance in the nonorganic universe endowed with semiosis and that this appearance of semiosis in the inorganic means a semiotic '*revolution* [since] the inorganic is now capable of modeling and thus has now become communicative ... in terms not only of semiosis but also of metasemiosis. Consequently, we can now claim that the machine endowed with language is a communicative nonorganism — the only one we know so far' (pp. 505–506).

Most semioticians agree with Petrilli's and Ponzio's premise that the semiosphere includes the biosphere. All living beings emit signs and act purposefully. The biosphere is a semiosphere (Hoffmeyer 1996). However, among the agents involved in processes of semiosis, Peirce does not only mention animals such as 'a chameleon and many kinds of insects' (*MS* 318: 205–206, 1907), microorganisms such as 'a little creature' under a microscope (*CP* 1.269, 1905), 'plants that make their living by uttering signs, and lying signs, at that' (*MS* 318: 205–206, 1907). Peirce also affirms that semiosis occurs 'in crystals, and throughout the physical world' (*CP* 4.551, 1906) and that the whole 'universe is a vast representamen' (*CP* 5.119, 1903).

The question whether there is semiosis in the inorganic world, too, has been hotly debated in Peircean scholarship (cf. Nöth 2001a, 2004). The key to this question is whether final causation, Peirce's main criterion of semiosis (cf. 3.1; Short 2007; Pape 1993; Santaella 1999), can be found in the inorganic world. In contrast to efficient causality, according to which an effect E is linked to its cause C dyadically and mechanically by 'blind compulsion,' the cause C of final causality attains its effect E triadically, teleologically guided by a goal, an aim, a purpose, or intention that can be reached by several means (cf. *CP* 1.211, 1902). With such an inherent goal, a process guided by a final cause is directed toward an effect whose realization lies in the future.

Such triadic interaction is Peirce's main criterion of semiosis. Communication with a sender's goal of conveying a message is the prototype of goal-directed semiosis, but final causality, according to Peirce, is inherent in the sign itself, not only in its sender's intention. The goal or even 'purpose' of a sign, affirms Peirce, is to 'be interpreted in another sign' (*CP* 8.191, 1904) and thus to create an interpretant. Signs do not only give evidence about their senders' intentions but they also inform about their objects, and they do so in a certain degree independently of what the sender actually intends to communicate (see 3.2). In the case of a lie, the sign, say, a testimony, due to the independent evidence it can give of its object and the inferences to which it leads, may even testify against its sender, for 'the purpose of signs — which is the purpose of thought — is to bring truth to expression. The law under which a sign must be true is the law of inference' (*CP* 2.444, 1893).

Did Peirce consider semiosis possible under these premises in the inorganic world? The question is relevant to the topic of sign machines since these machines belong to the inanimate world. The answers of Peircean scholars are divided between those who postulate a dualist dividing line between be semiosis in the biosphere and lack of semiosis in the physical world (Short 1998: 49, 2007) and scholars such as Helmut Pape (1989), Klaus Oehler (1993), and Lucia Santaella (1994, 1996, 1999) who adopt the synechist position that semiosis, according to Peirce, begins in the inorganic world in a gradual transition between matter and mind.

Does not semiosis begin in the inorganic world with the so-called natural signs, for example, the smoke that indicates a fire, the mercury of a thermometer that indicates a temperature? Evidently, the fire cannot intend to indicate nor pursue the purpose of signalizing the smoke which it causes. The event testifies only to a dyadic interaction, a cause-effect relationship of mere efficient causality, but nevertheless, the smoke that indicates its fire as well as the fingerprint that testifies against a criminal against his intentions, are commonly called natural (indexical) signs.

To the dualists, natural signs without a living sender have created problems in the framework of their semiotic architecture. Some have tried to solve it by introducing a dualist distinction between signs which have a living sender (the term is mostly 'symbol'), and signs without a living sender (sometimes called signal or indicator; cf. Nöth 2000: 187–192). Short (2007: 171) resolves the problem by projecting the triadic process of semiosis of natural signs into the interpreters' mind, concluding that natural signs are signs which do not produce their interpretants as a means to an end but which find interpreters who do so. Hence, natural signs are signs without a final cause in the physical world from which they emanate, but they involve triadic and purposeful processes nevertheless, since in such signs, 'the purposefulness of semeiosis is rooted in the interpreter, not in signs or their objects.' The indexical sign of the smoke indicating the fire as its efficient cause is a triadic sign because of the interpreter's act of attention which is directed by this index (Short 2007: 52).

The synechistic view of natural semiosis between matter and mind has been outlined by Ransdell (1977: 173), who sees rudiments of final causality in the physical world that gives rise to the natural signs interpreted by living beings. According to Ransdell, the facts and processes of nature exert an autonomous semiotic control on the outcome of the interpretation of the sign, the interpretant. Physical nature, by means of its natural signs, imposes cognitive constraints on the minds of its interpreters and restricts the possibilities of interpreting what they perceive. A cloud in the sky imposes itself on the perceiver as such and forbids its interpretation as a planetary nebula or even more so as a fingerprint. Furthermore, as long as human or animal observers of natural phenomena are still uncertain about what they perceive or as long as the perception is ambiguous, they tend to seek more evidence for a better orientation and interpretation of what they see. The meteorologist in search of the significance of a cloud will seek more signs to confirm the still vague hypothesis of a thunderstorm. Such search for orientation and signification in nature testifies to a form of control exerted by the dynamical object on the interpreter in search for interpretation. In this sense, rudiments of semiosis are involved in the physical objects of natural signs. The interpreters in search for further signs to decide whether their incomplete interpretation of nature is correct or incorrect are teleologically determined by the facts they are in search of.

Are these Peircean perspectives on semiosis in the inorganic world relevant to the question concerning semiosis in intelligent machines? If causal inferences from states of affairs as effects of physical causes involve semiosis, then all processes in the interface of humans and machines are processes of semiosis. However, this conclusion cannot provide any new insight as to the specific semiotic innovations brought about by intelligent machines. To answer the question whether such machines are sign machines, stronger criteria of semiosis are needed than the ones applied in the study of natural signs. The question whether intelligent machines are sign machines cannot be whether these machines or their output are merely interpreted as signs. The question must be whether they are autonomous agents in processes of semiosis. Autonomy is a relative term. To the degree that physical objects exert cognitive constraints on human cognition, these objects evince a certain, albeit weak, autonomy; after all, the control which they exert is not controlled by any other agent in the process. Hence, the degree of autonomy of an intelligent machine as a sign machine must be higher than the one of any material or technical object whatever. In a synechist perspective, however, the requirement should not be that the autonomy is as high and complex as the one of a human mind.

## 5. (Quasi-)semiosis, metasemiosis, creativity, and otherness

Claims 7 to 9 concerning semiosis, metasemiosis, innovation, creativity, and alterity are closely interrelated. Metasemiosis presupposes semiosis, and semiosis presupposes creativity, and otherness presupposes an autonomous self. The claims associated with these statements affirming the intelligence of machines are very strong; all of them have been challenged by dualist philosophers of the mind but also been defended by philosophers of computation.

Peirce had some radical ideas on machine semiosis (Nöth 2002). He who often used the term 'logic' as a synonym of 'semiotic' (or 'semeiotic') developed a theory of 'logical machines' in 1887 with reference to machines invented by Jevons and Marquand. His conclusion was that these mechanical devices as well as the calculating machines of his times were 'reasoning machines' (Ketner 1988; Skagestad 1993, 1999; Tiercelin 1993). Since reasoning is a process of semiosis, we might conclude that these machines were sign machines. However, Peirce suggests that they are not, although he goes so far as to conclude that '*every* machine is a reasoning machine' (Ransdell 1977: 168). Is reasoning then possible without semiosis? Elsewhere Peirce gives the answer: a machine such as the Jacquard loom, although capable of reasoning and calculating like humans, is not capable of 'the triadic production of the interpretant' and operates hence only as a *quasi-sign* (*CP* 5.473, 1905). Not even a cybernetic feedback system in which a mechanical signal triggers and steers an automatic process produces processes of semiosis. For example, Peirce argues, 'if the thermometer is dynamically connected with the heating and cooling apparatus, so as to check either effect, we do not, in ordinary parlance speak of there being any semeiosy, or action of a sign, but, on the contrary, say that there is an "automatic regulation", an idea opposed, in our minds, to that of semeiosy' (*CP* 5.473, 1905). The machines that Peirce discussed in 1887 were *deterministic* or, as Heinz von Foerster (1993) calls them, *trivial machines*, whose output is completely determined by their input. Such machines work on the principle of efficient causality and are only capable of *quasi-semiosis* and not of genuine semiosis.

In accordance with his synechistic theory of the gradual evolutionary transition between mind and matter, Peirce does not only conclude that the human mind when solving a mathematical or logical problem works like a mind machine, but also that the calculating and the logical machines of his time were capable of 'reasoning.' This similarity between human thought and merely mechanical 'reasoning,' according to Peirce, can be explained by the common evolutionary heritage of biological and physical nature: both the human brain and the physical laws of mechanics have evolved under the same cosmological constraints so that a certain degree of similarity between the operations of both can be assumed (cf. Nöth 2004). The mode of sign processing common to humans and machines is diagrammatic iconicity: 'The secret of all reasoning machines is after all very simple. It is that whatever relation among the objects reasoned about is destined to be the hinge of a ratiocination, that same general relation must be capable of being introduced between certain parts of the machine' (Peirce 1887: 168).

Elsewhere, though, Peirce makes clear that the kind of reasoning involved in human as well as in machine calculation is a very restricted mode of reasoning, covering only a small segment of the breadth of human reasoning. What is completely missing in deterministic machine reasoning is practical reasoning in the interaction with the machine's umwelt. In a letter of 1887, Peirce described these requirements for a fully human reasoning as follows: 'Reasoning is not done by the unaided brain, but needs the cooperation of the eyes and the hands' (quoted in Ketner and Stewart 1984: 208–209). This is a requirement that the intelligent machine will not be able to fulfil as long as it lacks windows to its own umwelt in space and time.

According to these premises, sign processes in deterministic intelligent machines do not involve semiosis but quasi-semiosis. If metasemiosis means 'awareness of semiosis' or even 'self-consciousness' (p. 218), the capacity of metasemiosis can even less be attributed to sign machines. Self-consciousness is a very strong semiotic criterion for a sign machine; it presupposes the ability to conceive not only of the self but also of the other, as Petrilli and Ponzio show (pp. 343–376), and even of the other in the self in which it is present in a permanent inner dialogue, which Peirce described in one of his reflections on the self as follows: 'A person['s ...] thoughts are what he is "saying to himself," that is, is saying to that other self that is just coming into life in the flow of time. When one reasons, it is that critical self that one is trying to persuade' (*CP* 5.421, 1905). Sign Machines are not programmed to carry out creative inner dialogues, they have no self to be dialogically persuaded, and even less a critical self which could once turn against the machine itself and its users. In a much weaker sense, however, sign machines are capable of metasemiotic operations, for example, generalization or classification of signs.

Deterministic machines cannot be said to be creative either; 'deterministic' and 'creative' are mutually exclusive predicates. Nevertheless, sign machines may be used as a means of enhancing human creativity, that is, as a medium for the realization of the creativity of their users, but in this case, their role in the process is one of efficient causality only, not of final causality. Sign machines are also the efficient causes of innovation, for example in scientific discovery, but they do not set their own goals of research, as would be required of a final cause of a true innovation.

## 6. Perspectives for semiosis in sign machines and rudiments of semiosis

Nevertheless, there are rudiments of self-knowledge even in deterministic machines, for example, autodiagnostic messages given by the machine on its own internal states such as a technical defect, lack of electricity, or storage capacity (cf. Kaku 1997, chapter 4), and there are rudiments of self-other interactions in the machine's dialogues with its users, with other intelligent machines with which it interacts, which it identifies, or recognizes, and with which it exchanges data.

If deterministic machines, steered by rigid programs in processes of mere mechanical causality, are only quasi-semiotic machines, what are the conditions for a truly semiotic machine? Are they possible at all? Not all intelligent machines are deterministic; a new generation of *nontrivial machines* (Foerster 1993), whose output is no longer completely determined by their input, has been developed. Here, first elements of autonomy and self-determination can be discerned. Do any of these machines operate by final causality? Important developments in the direction of sign machines that are no longer fully deterministic have been machines that learn and have the capacity of self-correction (cf. Carbonell 1990), bottom-up robots which learn to interact with their environment from mere trial and error without being preprogrammed with representations of the world which they interact with (Brooks 1991; Kaku 1997, chapter 4), and machines able to reason not only by deduction and induction, but also by abduction, a goal towards which Artificial Intelligence research has been striving for some time (Josephson and Josephson 1994). The implementation of such developments has brought about rudiments of semiosis in sign machines so far, but only the dualists refuse to imagine that further realizations of elements of semiosis in sign machines are possible.

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